CHAPTER 2

REVIEW OF LITERATURE
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OCCURRENCE OF POLLUTANT IN THE ENVIRONMENT
AND PLANTS:

Henderson (1959) worked on the toxic effect of effluent
released from a soap factory. Keller and Huckabay (1960) reported
pollution due to the sugar industry of Louisiana. It is observed that
the pollution problem due to sugar mill waste tends to be
concentrated both in location and time. The waste streams of sugar
mill drain in large swamp areas and as a result, tend to carry a high
pollution load in their natural state and causes pollution problem in
the local areas of Louisiana. Guzman (1962) studied cane sugar
mill waste disposal effect at Puerto Rico. Mill effluent found to be
highly toxic to the living organism present in the water bodies.
Chakrabarty (1964) conducted studied on the cane sugar wastes
and their disposal. The sugar mill wastes contain number of
inorganic and organic pollutants. These pollutants changed
chemical and physical properties of soil, water and air,

Verma and Shukla (1969) studied pollution in a perennial
stream ‘Khala’ by the sugar factory effluent near Laksar (district
Hardwar), Uttarakhand, India. The pollution of river and streams
by industrial waste has been the problem since time immemorial
because it produces the most unsanitary conditions in the
environment.
A characterization study of Kanpur wastewater was conducted by Schgal and Siddique (1970) to evaluate design criteria for a wastewater management programme. Per capita contribution of various constituents of the waste was reported along with the industrial contribution. This work suggested that present system of disposal of waste of irrigation and dilution in Ganges river may create nuisance in the river. Lagerwerff et al. (1973) made a study of plants and soil at the sight of a smelter and found that concentration of Pb, Cd, Cu and Zn in soil and plants decreased with increasing distance from the smelter. The metal concentrations in the plants were inversely related to the distance from the smelter. The metals had accumulated in the vegetation almost solely through uptake by roots. Kronfeld and Jeryz (1974) measured seven transition metals – Cd, Co, Cu, Cr, Ni, Pb and Zn in the water and sediments of a river system in Israel. Biologically significant amount of environmental contamination of Cd, Cr, Pb and Zn are being added to Gadura tributary throughout its course, while the build up is a potential biological threat, it is the high pH of several effluent water that inhibits the metal mobility. A sudden stoppage of the pollution appears to present a greater biological danger to the Quishon river and Heita Bay than and continuance of the pumping of these wastes into the river.

Watanabe (1974) conducted studies on the contamination of the water of Heita Bay due to reclamation with stags from a steel factory in Japan. Heavy metals like Mn, Zn, Cu, Pb and Cd contents of sea water, bottom mud and fishery products were analyzed. The Mn content of the sea water bottom mud was higher
as the distance from the reclaimed land decreased. Zn, Cu and Pb contents in bottom mud were higher near the inner part of the Bay. Heavy contamination of Zn and Cu was found in Oysters obtained from Haifa Bay. Asami (1975) collected ten surface soil samples near Kashima Iron works, of Sumitoma metal company, Japan. The soil near the iron work was found to be very coarse textured and those far from them had fine texture. The finer soil particles have more heavy metals than the coarser ones. Comparison of heavy metal contents of soils was done on soil particles with nearly the same diameters. The soil near the iron work have greater amounts of Fe, Mn, Cd, Zn, Cr and Ni and thus, seem to be polluted by these heavy metals discharged from iron work. Brodford et al. (1975) suggested that in recent years, concern about animal and human health hazards associated with heavy metals in soil and plants have increased tremendously. The concentration of the heavy metals in the industrial effluents is variable and often much higher than the contents observed in soils. The pollution potential associated with industrial wastes however, depends on the concentration and nature of heavy metals present in it.

Ellis and Kanamori (1977) made water pollution studies on the lake Illawara. Distribution of heavy metals in sediments collected from 18 sites of the lake was observed. These sediments showed marked enrichment of Cu, Zn, Cd and Pb. The highest concentration was found in Griffina Bay in the North-East corner of the lake which is closest to the Kembla industrial complex. Maximum enrichment for Cu, with soil from the area revealed the general order of uptake of Sn, Pb, Zn, Cu and Cd in a range of
vegetables. Sn was also deducted in herbage samples. Kumar et al. (1978) reported heavy metal accumulation in crops. Apichatubootra (1979) did studies on freshly harvested seed of some *Sorghum* varieties.

Verma et al. (1978) studied on the sugar factories and their wastes in Western Uttar Pradesh. The sugar factories waste in Western U.P. with the points of view to assess the magnitude of the pollution problem posed by these factories. Roszyk and Strajik (1978) studied on the effects of dustiness on the content of Pb, Cu and Zn in soils and grains of cereals in vicinity of a copper smelter. Near a foundry of the metals, studies on the contents of Pb, Cu and Zn in grains and top layers of soils from same places were conducted for 5 years. Banerji and Kumar (1979) reported twin effect of heavy metal pollution. Dinka et al. (1979) studied the element contents of the reeds in the lake Balatho (Hungary) and the accumulation of elements in the roads at the polluted and unpolluted banks. The amount of the elements (Pb, Si, N, P, Ca, Na, Mg, Fe, Mn, Sr and Cu) in the reeds and in various specific organs (culms, leaves, adventitious roots, rhizomes, and root hairs were studied at the banks of the lake that was polluted by sewage and the unpolluted banks.

Greszta et al. (1979) studied the effects of dusts emitted by non ferrous metal smelters, on the soil, soil microflora and selected tree species. The dust used in their field experiments results in the raised level in the soil of the following toxic trace elements – Cd, Cu, Zn and Pb. Cu-Pb-Zn dust was most toxic whereas Pb-Cu dust was found to be the least toxic to the plants. The resistance of
individual coniferous and broad leaf tree species to the dusts used to depend on their nature and amount added into the soil. The dust in the soil caused decrease in number of microbes and enzymatic activity.

Dutta and Mookerjee (1980) showed heavy metal pollution in grass and soil around a factory in West Bengal. For this soil samples collected from different sites around a cable factory in Rupnarayanpur were analyzed for heavy metals. In grass samples taken from same sites, traces of elements (Pb, Cd, Zn, Ni and Cu) were determined in root and shoots. Values obtained showed a high percentage of extractable and total metal in surface soil then in deeper layers of soil and from soils of relatively unpolluted areas that is 100 miles away from sampling site. Amount of extractable metal in soil and roots showed a high correlation. Merry et al. (1981) noticed contamination of wheat crop around a lead zinc smelter. Wheat grown in contaminated soil adjacent to Pb-Zn smelter was contaminated with higher concentrations of Pb, Zn and Cd then wheat grown in uncontaminated soils. Heavy metal concentrations in grains did not rise by surface contamination even at sites directly bear the smelter. In grains grown on polluted soils, heavy metal concentrations did not exceed prescribed health standards; certain aspects of industrial effluents on the seedling growth and anthocyanin development in Vigna radiata have been worked out by Singh and Bhargava (1982). Trivedi and Mall (1982) made a study on soil pollution due to alcohol factory at Ratlam and its effects on the structure and function of soil. From their field observations, it is clear that the wastewater, which has
highly acidic pH (4.25) and BOD (34,000 mg/l), high suspended and dissolved solids, has changed the pH of soil from alkaline to neutral.

Bhowmick and Singh (1983) analyzed various physico-chemical parameters of Ganges water at the meeting point of main sewage drain of Bhagalpur. Total bacterial density as well as coliform organisms increased abruptly at the confluence of the sewage. The ionic concentration viz. Ca, Mg, Na, K, phosphate – phosphorus, nitrate-nitrogen, bicarbonate free also increased considerably. Dissolved contaminated soil adjacent to Pb-Zn smelter was contaminated with higher concentrations of Pb, Zn and Cd then wheat grown in uncontaminated soils. Certain aspects of industrial effluents on the seedling growth and anthocyanin development in *Vigna radiata* have been worked out by Singh and Bhargava (1982). Trivedi and Mall (1982) made a study on soil pollution due to alcohol factory at Ratlam and its effects on the structure and function of soil. From their field observations, it is clear that the wastewater which has highly acidic pH (4.25) and BOD (34,000 mg/l), high suspended and dissolved solids has changed the pH of soil from alkaline to neutral. The nutrients of the soil result into the deterioration of surrounding vegetation, death of vegetation and disappearance of soil binding organisms.

Dissolved oxygen (DO) of river water got substantially reduced or even depleted due to sewage water. Gresztá (1983) noted an increase in the content of the heavy metals in the seedlings by comparing the content of Cu, Zn, Pb and Cd in particular parts of the plants collected from the areas treated with
different doses of dusts containing these metals. The biggest amount of heavy metals was found on the plots of oak, alder and beech; spruce, and larch assimilated the smallest amount of heavy metals. From contaminated soil, beech and fir assimilated the biggest amount of heavy metals while larch and pines the least.

Azad et al. (1984) studied the nature and extent of heavy metal pollution from industrial units situated in the vicinity of Ludhiana. Effluents from 10 leading units were sampled periodically at different times of the day. Analysis of these samples for heavy metals revealed that Zn, Ni and Fe in particular and Pb, Cd, Cu, Mn and Co in general were conspicuously more in effluents obtained from certain metallic industries. Further, they observed that concentration of these heavy metals is more in the evening than in the morning hours. Heavy metals in industrial effluents is variable depending upon the source and is often much higher than the contents observed in soil. Thus contents of effluents from different types of industries at Ludhiana show a great extent of variations. Arora et al. (1985) reported pollution potential of municipal wastewater collected from 13 outlets in Ludhiana city. Analysis of these samples revealed a wide variation in physico-chemical parameters, concentration of plants nutrients (K, P, Ca, Mg, Zn, Cu, Fe and Mn) and potentially hazardous heavy metals (Pb, Cd, Ni and Co). Merger of municipal water from 9 outlets into a sewage canal (Budha Nullah) conspicuously increased the level of all the elements in its water which is frequently used for irrigation. Similarly, the merger of 4 outlets into the Sihlwana irrigation canal increased the concentration of
hazardous metals to an extent that irrigating certain crops with this water may prove harmful to the consumer. Ashwa et al. (1985) studied the deposition of Pb, Cd and Cu in soil samples obtained from deonor (Bombay). The concentrations of these metals were measured by differential pulse – anodic stripping voltametry for event. Rainwater samples were also analyzed for heavy metal contents in the soil. The soil samples had substantially higher Pb level.

Bobby et al. (1986) evaluated some individual heavy metals (Cr, Ni and Co) in the aqueous sediments surrounding a coal burning generating plant by atomic absorption spectrophotometer. The aqueous sediments of several lakes around coal fired electrical plant have been analyzed for trace quantities of Cr, Ni and Co. Variations of track metal concentrations with respect to depth suggest a recent contribution to the aqueous sediment only where, there is an increase in the top 3 cms of sediment but such additions are minimal. Additionally, it is shown that Fe and Mn influence the distribution of trace metals within the aqueous sediment. The low levels deducted are attributed to the plant being in operation for only one to two years. Nevertheless, this efforts establishes invaluable baseline data for determining any future anthropogenic conditions due to either this coal fired plant or other industrialization of South West Hauston. Fytianos et al. (1986) investigated the heavy metals levels in various polluted and unpolluted water of river and lakes of North Greece. Samples of surface water were collected once a month from five rivers and lakes. River Axios was found to be highest polluted with heavy
metals like Pb, Cd and Cu. The main pollutants which flow into the Axios river originated in Yugoslavia and are affected by domestic effluents and industrial wastes.

Ananthraj et al. (1987) on the basis of their studies on pollution of river Cooum with sewage and heavy metals in Madras, stated that biotic life of Cooum river is severally affected by excessive discharge of sewage effluents within the city limits, which excessively eutrophicate the river water. The number of species and the density of zooplankton were very low in this river. Heavy metals such as Ni, Fe, Pb and Zn were above permissible levels. Agarwal et al. (1980) reported in general, contamination of air, soil and plants by many toxic metals (Pb, Zn, Mn, Ni, Cr and Cd) in the vicinity of a zinc smelter even up to 7 Kms, in down wind direction. But inter correlation of statistical significance of accumulation by plants with air concentration or even with aerial distance could not be established but for peculiar topography of the region and other microclimatic condition generated. Leaves of wheat found to accumulate maximum of Fe but the leaves of mango have maximum Zn, where as minimum pick up of Zn and Fe content were found in Acacia species. However, significant indirect exposure of man through vegetation-cattle-man chain cannot be ruled out due to high frequent uptake of certain heavy metals like Zn and Cd. Rico et al. (1989) have studied the water contamination due to 5 heavy metals (Pb, Cd, Hg, Cu and Zn) in Donand National Park Spain. The samples of polluted water bodies were analyzed and possible health hazards were discussed.
Lalman and Dixit (1989) reported changes in water quality by industrial waste disposal. The liquid effluent of a sugar factory and a cardboard factory are discharged into river called Suawan. The extent of pollution of river water and nearby underground water has been studied with increasing distance in the river and growing severity of pollution due to increased addition of pollutants.

Govardhan (1989) studied heavy metal pollution of different inlands lakes of Northern Himalaya. Inland lakes are vital resources to provide water, food and recreation for human beings as well as habitat for many species of plants and animals. The work summarizes the heavy metal pollution of different lakes of Himalaya. The lake water recorded comparatively less heavy metal concentration with sediment of different lakes. The clay fraction of rural, urban and forest lake sediments recorded greater amount of heavy metals than mountain lakes. The sewage and sludge analysis showed that it acts as a main source for the heavy metal concentration in Dal Lake complex. The Dal lake water and sediment analysis in different locations showed a great variation in heavy metal concentrations. The greater concentration of Cu, Cd, Pb and Cr in water and sediment revealed the intensity of anthropogenic activity in the different lake environments. Phosphate showed a positive correlation with Cu, Pb, Zn and Mn. It is concluded that irrational dumping of municipal waste including sewage and sludge, discharge of paper, carpet and wool industrial effluence and vehicle exhausts are the main causative
implications for the pollution of inland lakes of Northern Himalaya.

Hundal and Sandhu (1990b) studied accumulation and distribution of various heavy metals in soil irrigated with sewage wastewater. They collected soil samples with distance along the sewage drain, from 3 types of fields that is sewage waste water irrigated, mixed water irrigated and tube well water irrigated and analyzed for total, and DTPA extractable toxic metal (Pb, Cd, Ni and Cr) contents. Total metal concentration found by analysis was higher in the sewage waste water treated soils than that of the untreated soils and it decreases as the distance from the reference point increases, DTPA extractable contents of these metals (except Cr also increase in sewage waste water irrigated soils as compared to tube well water fed soils. Metal availability was greater in treated soils than the untreated soils. The order of percentage availability in sewage fed soils is Pb > Cd > Ni > Cr and in the tube well water irrigated soil is Cr > Pb > Ni > Cd. Attempts were made to study accumulation of these heavy metals.

Baca et al. (1992) reported effect of the addition of sugarcane bagasse composts on micronutrient assimilability in ryegrass. Five treatments were prepared; soil alone (C), soil + mineral complements of N, P and K (NPK) and three treatments, containing soil + different sugarcane bagasse composts at 100t ha. A ryegrass culture (Lolium perenne L. cv. varna) was grown in pots from which five harvests of plant material were obtained. Soil samples of each treatment were collected before sowing and after the third and fifth harvests. The addition of sugarcane bagasse
composts to soil increased DTPA extractable Fe, Mn, Cu and Zn throughout the entire experiment in comparison to C and NPK. These organic materials also led to an increase in Fe, Cu and Zn uptake by plants after the second harvest.

Nakagawa et al. (1993) studied effect of sugarcane bagasse, decomposed by biofertilizers (Amizin and Orgamin), on yield of lettuce \( (Lactuca sativa, \ L) \). Two experiments were carried out under semi controlled condition to study the effect of sugarcane bagasse composts on lettuce crop. Seven composts were used; I sugarcane bagasse (SCB) + Water + Manure, II SCB + 15% Amizin (A15), III SCB + A20, IV SCB + 5% Orgaminb (O5), V SCB + O10, VI SCB + O5 + A15, and VII SCB + O5 A20. The statistical design used was a completely randomized, with three and four replication for the first (with cv. Brasil 305) and second (with cv. Grand Rapid) trials, respectively. Before each trial some soil characteristics such as base saturation, P-labil and exchangeable K were corrected to 750%, 250 µg/ml and 0.35 meq/100 cm³ of soil, respectively. Additionally 1.0 g/pot (four applications) of urea were applied as side dressing. Those applications corresponded to the last four and three weeks of the lettuce vegetative cycle. The result showed that, the Chlorophyll content was not altered, the foliar area of the largest leaf was affected and the number of leaves and leaf, stem and total plant (except roots) weights were also affected by the different composts. It was also observed that the treatment I, II and III were the best combinations, followed by the treatment VI and VII. However, when Orgamin was used alone for the composting, it gave the lowest response. This adverse action of
Orgamin could be due to nutritional imbalance of the cautions included in the material.

Swaminathan et al. (1993) found that the toxicity of the tannery effluent was due to suspended solids, nitrogen compounds, oils, grease, tannins, lignins and the metallic ions, chromium, sodium and potassium that were present in the effluent. These toxicants reduced the phytoplankton population and primary productivity in the canal water. But seven algal forms were found to be very resistant to these toxicants. Among these resistant forms *Spirulina major*, *Anabaena* sp. and *Nitzschia sigmoidea* were present only in the polluted waters; so these forms could be used as pollution indicators.

They suggested that in India, discharging the tannery effluents into the water bodies is a very common practice, as a number of small scale tanneries which utilize considerable amounts of water are situated along the banks of rivers, streams and canals. These effluents contain heavy metals and organic pollutants which are quite hazardous and can deplete the dissolved oxygen content of the water and affect the aquatic biota and their community structure. Pollution load in any water body may be assessed by physico-chemical analysis and by following the species numbers, composition and the changes in the microbial communities of the water body. Among the microbes, the algae can serve as a good tool for assessment of the effect of toxic effluents because of their simple structure and preferential aquatic habitat. The present study deals with the effect of tannery effluents on the physico-chemical
characteristics of an irrigation canal water and on the phytoplankton community and primary productivity in that canal.

Wells et al. (1993) investigated content of some heavy metals in soil and corn grain. In an attempt to find causes for lower than expected corn (Zea mays L.) production along the bottom lands of the Green and Pond Rivers in Western Kentucky, corn fields were sampled for soil and corn grain to determine heavy metal content. Samples from sixteen carefully selected fields were analyzed for Cd, Cr, Pb and Ni content. Yield of corn was not related to either soil or grain content of these heavy metals. There was also no relationship between soil pH and heavy metal accumulation by grain or heavy metal accumulation by grain and soil content of heavy metals within the range of levels found. Soil contents of Cr, Pb and Ni were within the range of values reported in the literature for uncontaminated soils. However, soil content of Cd was near or above the upper end of the ranges reported in the literature, even on control samples taken upstream from sites of potential heavy metal pollution. Karnak soils (fine, montmorillonitic, nonacid, mesic Vertic Haplaquepts), which are high in montmorillonitic clay content and have high cation exchange capacities had higher Cd content than the other soils samples. Except for two sites, grain Cd content was similar to values reported in the literature. Corn yields were found to be generally lower on Karnak soils than on other soils, raising the possibility that observed lower than expected yields are related to the poor physical characteristics of these soils rather than heavy metal pollutants in floodwaters.
Barman and Lal (1994) reported accumulation of heavy metals (Zn, Cu, Cd, and Pb) in soil and cultivated vegetables and weeds grown in industrially polluted fields. The present investigation deals with the study of heavy metal accumulation in field receiving industrial effluents and subsequent bioaccumulation in the standing vegetables and weeds. The level of heavy metals (Zn, Cu, Cd, and Pb) in the cultivation fields adjacent to Durgapur Industrial Belt (DIB) was found to be much higher than the background level. Bioaccumulation of these metals in different parts of the different plants species were found either within or beyond the con. (Critical concentration) and maximum localization were found in the edible parts followed by non edible leaves and shoots. The pie diagram reveals heterogeneous accumulation of heavy metals depending on the plant species of the plant. This study can be applied in selecting the plant species suitable for cultivation in fields giving high levels of heavy metal contamination.

Hariom et al. (1994) studied combined effect of wastes of distillery and sugar mill on seed germination seedling growth and biomass of Okra (*Abelmoschus esculentus* (L.) Moench). Study was undertaken to investigate the combined effect of effluent of distillery and sugar mill at different concentration viz., 5, 1.15, 25, 35, 50, 75 and 100 percent (v/v) on seed germination, seedling growth and biomass of okra. Germination percentage, seedling growth and biomass increased up to 25% effluent concentration and germination was completely inhibited in 100% effluent. Germination was noted in 75% effluent, but seedling did not
survive. However, the wastewater of distillery and sugar mill may be used for irrigation after diluting the effluent to 75%.

Hosetti (1995) worked out treatment of sugar industry effluents by ponds and lagoons. The effluents of Kumbli Kasari Sugar factory, Kuditre, Kolhapur, was treated by the physico-chemical and biological methods viz. colour removal, pH adjustment, lagooning, aeration and ponding. Finally treated effluents were used for irrigation. The BOD of the mixed waste 247.5 mg/l was reduced to 155 mg/l in the distal oxidation pond. Significant reductions in alkalinity, chlorides, hardness and calcium levels were recorded. The observation revealed that the regular undertaking of sludge removal from the ponds may certainly improve the overall efficiency of the treatment system.

Kaur et al. (1996) worked out Hindon river monitoring spatio temporal variations. The quality of the river water depends upon the catchment characteristics, land use in catchment area and the last but not the least, the quality of effluents disposed off in the river by different industries and towns. Hindon is a tributary of River Yamuna and is an important river of western Uttar Pradesh which collects waste water from major towns like Saharanpur, Muzaffarnagar and Ghaziabad. Without improvement in the quality of River Hindon, the on going cleanup of Yamuna and Ganga would not produce commensurate results. It is, therfore, important, to regularly monitor the Hindon River. Based on reconnance survey of the Hindon basin five stations namely Mahespur, Barnawa, Daruheda, Mohan Nagar and Noida were identified for sample collection. Sub surface sample were collected
once a month and analyzed for physical, chemical and bacteriological parameters. Trend in water quality in two consecutive years has been analyzed and compared.

Sarin (1996) reported chemical speciation and bioavailability of pollutant in aquatic environment. Among various constituents that signify the quality of natural aquatic systems, the heavy metals have become a topic of significant concern for environmentalists, chemists and engineers. This is mainly due to non biodegradable nature of metals which are directly or indirectly harmful to man and aquatic life even at trace concentrations. Hence, increasing attention is being directed towards studying the concentration and transport of metals and their effect on environment. The metal ions get introduced into aquatic environment through increased human and industrial activities. The fate of these metal ions does not remain static due to the presence of numerous organic and inorganic compounds combined with dynamism in the natural aquatic system. These metal ions undergo certain physical, chemical and biological interactions within the aquatic system, thus producing a new set of constituents referred to as heavy metal species. The different physico-chemical forms of pollutant often exhibit varying degrees of physical, chemical and biochemical properties, thus causing detrimental effects on aquatic system and human life that thrive on it. It has been studied that water having high concentration depending on the nature of chemical form of the metal. Thus, the biologically available fraction of a particular heavy metal is dependent on the chemical form of the metal in solution. It is inevitable that in the near future, water quality
legislations for heavy metals will include statements relating to their physico-chemical form. It is therefore, emphasized that investigation of various physico-chemical forms of heavy metals is necessary for understanding their pathways and sinks in aquatic systems and risk of metal resolulization from sediment sinks, their toxicity towards aquatic organisms and understanding the biological and geochemical cycling. The procedures that can be used to study the bioavailability of heavy metal species in waters are ion exchange, ultra filtration, dialysis, solvent extraction and electrochemical.

Khan and Ali (1996) published chemical time bomb due to environmental influences of anaerobic lagooning of distillery and sugar mills effluent. The disposal of industrial wastewater is major challenge to mankind which has attracted global attention of environmentalist and biotechnologist for the conservation and management of natural resources for future generation. Of course, sugar mills, distilleries, fertilizers, insecticides, pesticides, weedicides and paper factories are polluting surface, ground water, air and soil causing imbalance biodiversity. These are creating nuisance to agriculture and environment in India. The ground water samples from 2 Km around Kutch Lagoons of the sugar mills and distillery, Simbhaoli were studied from water table at different depth since 1975, physico-chemical parameters pH, surface tension, viscosity chloride, sulphate, heavy metals, BOD and COD were analyzed. Bed odoured brown water of hand pump and tube wells revealed deep percolation of acidic effluent after in filtration in sandy soil. Accumulation and immobilization of
pollutants in sediments lead to loss buffer capacity of soil render vulnerable to adverse effects from “Chemical sink” Chemicals time bomb. High pH, BOD, COD and organic load of pumped up water causing surprising changes broad side die off of *Poncirus trifoliata* in college campus delay in heating periods and reduction of milk production in cattle. Hepatitis, gastroenteritis, chronic dysentery, gastric disorder, dyspepsia and skin disease have been recorded in teachers, students and local inhabitants. The effluent treatment plant, (ETP), after biogas production, releases much lower BOD but higher to permissible limit, in distillery since 1993. Standard required BOD to be reduce 30 mg/l to disposal in river and 100 mg/l for land. The effluent from ETP of distillery, sugar mills and fertilizer factory (Gajraula) contains NPK, the manorial constituents paved the way to soil fertility and can be utilized after proper dilution to raise Sugarcane, Wheat, Maize, *Brassica* crops economically with low cost of cultivation. However, it is not suitable for leguminous crops e.g. Pea etc. This way pollution may be eliminated by using the waste water in agriculture for sustainable development and will create healthy environment for flora and fauna in the country.

Sharma et al. (1999) worked on environmental pollution at Sanganer, a suburb of Jaipur, has almost 400 textile units, which discharge approximately 4000 KI. of dye wastewaters everyday in the adjoining shallow pools an the drain. The characteristics of dye wastewaters and their impacts on flora, fauna, soil characteristics, ground water, vegetable and cereals growing in the vicinal areas
have been examined in detail. This study points out an urgent need of wastewater treatment prior to its discharge in the water bodies.

Poonkodi and Raghpathy (2001) suggested that the development of science and technology has improved the quality of human life. Concomitantly, however, the problem of accumulation and disposal wastes has assumed serious. The eco-friendly technologies help in generating wealth from the waste. With a high production target of food grains for the coming years, the inorganic nutrient sources should be gradually dispensed with the alternative organic nutrient sources and industrial wastes. Keeping this in mind, an attempt has been made to study the efficiency of different industrial wastes viz., LFA, an industrial waste from Thermal Power Stations, press mud, a waste from sugar mills, pyrite, a waste from steel factories, in improving the yield and quality attributes of soyabean, and compared them with conventional sources of sulphur namely, gypsum and elemental sulphur.

Kumar (2001) reported that Chakia Sugar Mill Effluent contained high pollution load (chemical oxygen demand, total slides, calcium and total alkalinity). Value of dissolved oxygen has been found below the minimum required. Presence of oil and grease in the effluent further increases toxicity. Their experiment was conducted to assess the impact of effluent on cell cycle and its component phases in *Hordeum vulgare* IB-65.

Bhargava et al. (2003) worked on the distribution of total N, P and heavy metals in the soils and sugar cane crop plants as affected by automobile exhausts.
Reshu and Bhargava (2004) studied the presence of heavy metals in the saliva of population living near Roadways bus stand. They also observed effect of heavy metal on human saliva.

Kumar et al. (2006) studied distribution of total N, O and heavy metal content in the roadside soil and rice plant as affected by automobile exhausts. Dhiman et al. (2006) studied the distribution of total Nitrogen, total Phosphorus and heavy metals in the plant parts of *Terminalia arjuna* (Roxb.) growing along roadside as well as near industrial area of Saharanpur (U.P.).

Raut et al. (2007) suggested that pollution is the dark side of industrialization and its impact on man, agriculture and forestry is of serious concern. Pollutants are effectively concentrated around the biological system and its effectiveness reflects typically in food chain. Some pollutants degenerate either naturally or through engineered systems, where as some dangerously accumulate in their present state and exercising their harmful effects and unbalancing the ecosystem.

Industrial effluents, originated with the dawn of industrial revolution are regarded as waste and hazardous components from early days and they are disposed off in nearby water bodies as a load with or without treatment. Therefore, treatment of the effluents before their reuse is considered as one of the ways to overcome the problem of pollution. An effluent released from various distilleries units induces harmful effects in plant system at metabolic level. The present work was undertaken to highlight the
significance of the impact of pollutants which are released from distilleries units on plant system.

*Vigna sinensis, Vigna radiata, Triticum aestivum and Zea mays* were selected as an experimental system for the present study. Ecological parameter such as productivity deserves an equal importance when the plant system is used as dietary component and hence the ecological parameter such as stomatal index and productivity also has been studied.

**UPTAKE OF POLLUTANTS BY PLANTS**

Lagerwerff (1971) studied an uptake of some pollutants by radish from soil and air. They noted that the increasing concentration of Pb & Cd in environment causes adverse effects to human health. Inhalation and ingestion are the mode of entry of the metals into man. Consumption of solid food is the main pathway. In order to devise a method for minimizing the content of Pb & Cd in food crops, studies were carried out to know the origin and environmental behaviour of the metals as well as on conditions affecting their by plants. Pb & Cd were added to soil in certain fertilizers and pesticides. It was found that they also reach soil and plant cover from the air. Aerial Pb is generated mostly by combustion of gasoline in vehicles; Cd is due to metallurgical activities industrial burning practices and from attrition of car tyres. Due to fall out of larger particles, road sides’ concentration of Pb & Cd in both soil and vegetation decrease away from traffic. The heavy metals enter the food chain by uptake through the roots and by foliar spray absorption or adherence. Bingham et al. (1976)
reported Cd availability to rice in sludge amended soil underflood and non flood culture. The plants were grown to maturity in pots containing soil amended with 1% sewage sludge enriched with variable amounts of CdSO₄ ranging up to 640 µg/g. Two sets of soil culture were used - rice under flood management was relatively unaffected by the Cd between; 25% yield document was associated with a treatment of 320 µg/g. Under unflood management, however, a comparable document in gram production was observed with a treatment of only 17 µ Cd/g. The Cd, contents of mature leaves at early flowering varied from approximately 0.3 µg Cd/g for control to 2.8 µg Cd/g for plants receiving the highest Cd treatments. Leaf Cd values were slightly higher under the unflood culture. The Cd content of mature leaves correlated with grain production under flood management. The Cd was greatly reduced in soil under flood management which may account for the greater tolerance of the cultivar to soil Cd under flood culture. The reduced availability of Cd in flood soils is attributed to precipitation of Cd.

Hinesly et al. (1976) studied on soyabean yield responses and assimilation of Zn & Cd from sewage sludge amended soil. Soyabean plants were planted annually on plots that were irrigated with digested sludge from 1969 to 1974. The yields were increased by sludge application each year except in 1972 when plant receiving the maximum application rate suffered from P toxicities. Although Zn & Cd contents of soil were substantially increased by sludge application, a phytotoxic condition attributed to metals was never observed. Both Zn & Cd in plant tissues were influenced to a
much greater degree by the amounts of the elements incorporated into soils just prior to a particular cropping season than by total accumulated amounts. Furthermore, one year after sludge application lower than those observed in similar tissue samples collected previous year. The sludge was continuously applied at annual loading rates, which would not cause N\textsubscript{03} - N pollution of ground water and the concentration of Zn and Cd in Soybean seed would not exceed tolerable levels for consumption by animals.

Grodzinski & Kazmierazakowa (1977) studied heavy metal contents in plants of Cracow parks. Concentration of Cd, Pb and Fe were determined in the leaves of \textit{Sambucus nigra}, in the above and underground parts of \textit{Taraxacum officinale}, \textit{Poa annua}, \textit{Lolium perenne} and in mosses collected for studies from 4 cities parks of Cracow (Poland). These parks lie at various distances from the huge steel mill located in Eastern part of the city. In vascular plants, the Cd ranges from 0.35 to 6.82 ppm, Pb contents from 0.05 to 28.60 ppm and that of Fe 225 to 8760 ppm. Mosses accumulated Cd at concentration of 2.27 to 2.66 ppm, Pb at 28.81 to 46.25 ppm and Fe at 3087-7440 ppm. The concentration of heavy metal decreases as the distance from the steel mill increases, which points to the later as main source of emission. The plant also picks up additional Pb from combustion gases; the accumulation of this heavy metal is usually higher in the plants of the park’s peripheral zone than in the central zone.

Sreeramulu et al. (1977) worked on the growth and survival of \textit{Ulva fasciata} in the polluted sea water of Visakhapatnam Harbour. The rapid degeneration of \textit{Ulva} discs with marked
reduction in growth was observed in the waters collected near the Southern lighter canal, polluted by untreated town sewage. In the waters of Northern and Western areas of Harbour, growth rate was slightly more than that was observed in the waters collected from unpolluted sites as control but 22 to 30% of Ulva discs died at the end of the experiments. The water of Visakhapatnam Harbour thus was toxic to the growth of Ulva fasciata. Munshower (1977) reported the accumulation of Cd in plants and animals of polluted and non-polluted grasslands of Southern Western Montana, U.S.A. Primary emphasis was placed on agriculturally important plants and animals. One of the sites had a history of pollution from a smelter, while the second site had no history of industrial contamination. Determination of extractable Cd in soil collected at intervals along a line from the smelter to the polluted study site showed that this smelter was probably, the source of the high soil Cd level. The Cd level in soils, plants and animals collected from the site near smelter complex was found high. The average Cd level in samples collected from polluted & non polluted areas were-grasses (Agropyron & Stipa) - 1.72 & 0.72; Alfalfa - 0.83 and 0.06; barley grain - 0.65 & 0.08; tissue of cattle liver - 0.34 and 0.06; and cattle kidney - 1.67 & 0.22 ppm Cd. Dudas & Pawluk (1977) analyzed several agricultural soils and cereal crops in Alberta (Canada) for the estimation of heavy metals.” The abundance of these heavy metals was found to be low and represent levels naturally present in uncontaminated soils. The drainage contributed significantly to heavy metal redistribution in soils. Levels of heavy metals were also determined in seeds and straw of cereal crops grown on these soils. Vegetative samples were found to have low
amounts of heavy metals. Amounts of Cd, Pb & Hg were significantly higher in straw than in respective seed samples.

Charles & Linnemann (1977) reported the feasibility of disposing Pb & Zn cations in soil. The study was from the new lead belt of South East Missouri, U.S.A., an area which is the site of one of the world’s largest Pb & Zn mining and milling operations. The compounds studied were lead and zinc acetate and fluroborate. These compounds were loaded on soils columns separately as well as in combination and were leached with a variety of materials including a simulated rainfall solution and a solution containing humic acid leached from the leaves of the region. On the basis of these experiments, they suggested that soil cationic exchange capacity was high enough for disposal of these wastes and would not represent a danger to the shallow ground water table.

Lage & Elsokkary (1978) observed the presence of certain heavy metals in some food crops grown in industrially polluted soils at Odda, Norway. High soil contents of toxic heavy metals have generally been observed in the proximity of industrial estates. They indicated that the industrial wastes whether applied to agricultural land in amounts determined by nutrient demands, spread, dumped, sprayed, ponded, injected or in some way deposited on or into the soil, carry the heavy metals into the soil environment. Eide et al. (1980) showed long term uptake and release of heavy metals by Ascophyllum nodosum in situ by transferring whole plants from localities with low to area with high levels of heavy metals in the water and vice-versa. Zn & Cd were taken up very slowly in winter and quickly in summer. Pb uptake
showed little seasonal variation. Results of Hg were less clear but indicated a moderated seasonal variation. They concluded that uptake & release of Zn & Cd required an input of metabolic energy, while accumulation of Pb may be governed by anionic exchange process similar to that for Sr. Ruick & Schmidt (1981) noticed behaviour of certain heavy metals in tobacco. The contents of Cd, Pb, Cu & Zn decrease with the increase in plant size. In mature plants Cu content increased from root to flower. Maximum concentration of Pb was found in root. Zn was almost evenly distributed throughout the shoot axis. Zn increased with increase level of leaves on the shoot axis.

Vanderwerff & Margreet (1982) studied the long term experiments lasting up to 73 days. The effect of rather low levels of Zn, Cu, Pb and Cu on the growth and metals uptake was studied by investigating four aquatic plants—Elodea, Ceratophyllum, Spirodelas & Lemna. Except Elodea, which was already very sensitive to Cu & Pb, no differentiation in growth or mortality could be detected depending on species or element. The uptake level of heavy metals in submerged species was more than in floating species. The involvement of roots in element absorption by aquatic plants & the possibility of using aquatic plants as indicators of heavy metal pollution in Dutch water were also discussed. Bhargava (1984) studied uptake of heavy metal zinc from soil. Bhargava (1987) summarized the uptake of heavy metal by Vicia faba crop. Two concentrations of Zn amended soils (10 mg & 50 mg Zn/kg soil) were used to evaluate the effect of Zn phytotoxicity on the absorption of heavy metals from soil by Vicia faba adult
plants. Studies have indicated that the total heavy metal content on unit weight basis of plant grown on Zn amended soil in this crop are more than those grown on control soil. Singh & Verma (1988) studied Cu uptake in Nostoc calcicola and found that Cu uptake pattern was a curvilinear function of time and it followed Michaelis-Menten type of kinetic with saturating concentrations at 40 µm. a positive correlation existed between Cu uptake and growth inhibition at pH from 4 to 10; maximum Cu uptake and toxicity was observed at low pH. Cu uptake seemed to be dependent on light and metabolic energy. Bhargava (1995) also studied uptake of heavy metal by crop plants from polluted river water. Richa et al. (2003) reported heavy metal uptake by sugarcane from polluted soil.

**PHYSIOLOGICAL EFFECTS OF POLLUTANTS:**

Kumar (1978) studied the effects of polluted irrigation water on crop plants. He suggested that such irrigation practice although do not necessarily have any apparent deleterious symptoms on the crops but lead to heavy metal accumulation in edible parts of crop plants. Chou et al. (1979) studied the impact of water pollution on crop growth in Taiwan. Wastewater coming from 7 factories was analyzed for phytotoxicity and physico-chemical properties. The effect of water on the growth and yield of rice plants in pots was studied. The wastewater exhibited significant phytotoxic effect on the radicle growth of rice, lettuce and grass. Lettuce was the most sensitive species to waste followed by rice and rye grass. The phytotoxicity varied with industrial wastewater and with time of sampling. The toxicity was higher in day time than the evening.
Wastewater retarded both the vegetative and reproductive growth of rice plants grown in pots. The suppression of yield was obvious in the second crop, resulting in decrease of panicle number, ripening rate, weight and grain yield. The physico-chemical analysis of these wastewater revealed that the values were often above the limits of the standard criteria for irrigation water for agriculture land. Some of these properties were the cause of phytotoxic effect on plant growth.

Zwarich & Mills (1979) described the effects of sewage sludge application on the heavy metal content of wheat and forage crops. A growth chamber experiment was employed to investigate the effect of digested sewage sludge application on the heavy metal content of wheat, borne and alfalfa forage crops. Samples of wheat were also obtained from fields which have received heavy application of sludge. Cu level in wheat kernels and straw were only increased slightly but copper level in the forage crop was elevated by this sludge treatment. There was a considerable increase in the Zn content of all crops but levels were not excessive. Sludge treatment produced up to a 6-fold increase in the Cd and Pb contents of wheat kernels and a considerable increase in the Cd content of the forage crop. The increased Cd and Pb levels are undesirable, but can be controlled by restricting the sludge application rate. There was little or no effect of sludge treatment on Cd and Pb levels in wheat straw.

Dijkshoorn et al. (1979) showed phytotoxicity of certain heavy metals on 3 pasture plant species supplied with graduate amounts from the soil. Narrow leaved plantain (Plantago
lanceolata), white clover (*Trifolium rapens*) and rye grass (*Lolium perenne*) were grown on acid sandy soil with added levels of Zn, Ni, Cd, Pb, Cu and Cr as the single test element. The metals were classified for inhibitive metal concentration in the shoots of plants and in the soil - Ni, and Cu covered a 5 fold range. With one exception, Cd in plantain was inhibitive at a 10 fold higher tissue concentration than in clover and grass. Zn was more efficiently absorbed but tolerated at a higher soil concentration because it was much less toxic to the tissue. Cr was tolerated as low shoot concentration but at high concentration in the soil because its uptake by the shoot was disproportionally smaller. Difference between plant species in response to the soil test levels were illustrated in terms of relative uptake and shoot concentrations for toxicity. Shukla & Dwivedi (1979) showed influence of trace elements on growth of rhizobia and nodulation in *Trifolium alexandrinum*. The effect of 4 trace elements (ZnSO$_4$, MoO$_3$, MnSO$_4$ and CuSO$_4$) on the growth of 5 different strains of *Rhizobium* was studied in vitro at 10, 50, 200 and 400 ppm. CuSO$_4$ inhibited the growth of all the test rhizobia at all concentrations while ZnSO$_4$ did so at 50, 200 and 400 ppm; MoO$_3$ and MnSO$_4$ were in-effective at all concentrations. The effect of foliar spray of 3 trace elements (ZnSO$_4$, MoO$_3$, MnSO$_4$) on nodulation of *Trifolium alexandrinum* was studied at 50, 100 and 150 ppm. MnSO$_4$ increased the number of nodules marginally at 50 ppm and decreased at 150 ppm. ZnSO$_4$ decreased the nodule weight at 150 ppm where as MoO$_3$ did so at 100 ppm.
Mutlak et al. (1980) suggested that the potential hazard of pollution due to sewage farming, as it is practiced, threatens vegetables grown on the farm as well as ground and surface water of the nearby area. Sewage farming may seriously affect the consumers. This study showed that both sewage and soil irrigated with sewage contained the indicator and the pathogenic bacteria and therefore, use of untreated sewage for agriculture use is hazardous. It is recommended that the conventional methods for sewage treatment be adopted. Bhargava & Singh (1982) found that seedling growth of certain cucurbits and legumes was promoted at lower concentrations and inhibited at higher concentrations of Ni and Zn given as NiSO₄ and ZnCl₂ respectively. Growth in soil amended with Ni was also promoted. However, soil amended with Zn was found inhibitory. The uptake of N and P was promoted at stimulatory concentrations and suppressed at inhibitory concentrations. Considerable organ specific, species specific and cultivar specific differences in response to heavy metals were observed. The use of resistant cultivars/accumulators in heavy metal polluted regions is suggested. Chang & Broadbent (1982) evaluated the influence of trace metals on N immobilization, N mineralization and nitrification, was measured during the two to four weeks period and N mineralization and nitrification during four to twelve weeks period. At low levels of metal addition, Pb and Mn stimulated N immobilization but at 400 ppm all metals were inhibitory to all N transformations. Among the six metals studied, the sequence in order of decreasing inhibition was Cr>Cd>Cu>Zn>Mn>Pb. Thus, they concluded that N
transformation rates may be affected by trace metals in solid receiving heavy sludge applications.

Tandon (1982) studied the uptake of N, P and K in four cultivars of rice (IR-20, Jaya, Pusa 2-21 and IET 1444) cultivated on sandy loam soil with increasing doses of heavy metals. Zn reduced uptake in case of Pusa 2-21 and IET 1444 in IR-20 and Jaya, only the higher dose of Zn (40 Kg/ha) did so. Higher doses of Zn also significantly reduce the P uptake. K uptake was significantly enhanced on Zn application in all the four cultivars. N uptake was increased by the lower dose of Fe while the higher one reduced it. P uptake was not very much influenced by the lower dose of Fe, there being an increase in IR-20 alone, but the higher dose caused a reduction in uptake of this nutrient. K uptake was increased by lower dose of Fe while the higher dose reduced it. Bhargava (1983) described the effect of heavy metal Zn on seedling growth and P distribution in Vicia faba. He found that germination percentage of Vicia faba decreases with the increasing concentration of zinc. At 10 mg/l concentration, the germination is Ca. 92% and at 50 mg/l concentration, it is about 88%. At lower concentration the extent of inhibition, length and fresh weight wise is same in radicle & epicotyl on all days. At higher concentration the extent of inhibition on 3rd day is equal to that of lower concentration but at later phase both organs shows more inhibition.

Sahai, et al. (1983) studied the effects of distillery waste on seed germination seedling growth and pigment content of rice.
Kumar & Bisht (1986) studied the effects of excess heavy metal supply on metabolism of green gram (Vigna radiata) during germination.

Srivastava (1986) studied the effects of distillery waste on the seed germination seedling growth and pigment content of Cajanus cajan.

Singh (1986) studied the effect of heavy metal nickel on seed germination, seedling growth, total N and P distribution in three cultivars of Pisum sativum. He found twin action of Ni i.e., promotion of germination at 1.70 x 10^{-4} M, Ni concentration and inhibition at 8.5 x 10^{-4} M, Ni concentration.

Srivastava & Sahai (1987) also studied the effect of distillery effluent waste on the performance of Cicer arietinum, L.

Waly (1987) studied 9 profiles taken from a farm, 25 Km North East of Cairo, to investigate the effect of prolonged irrigation with sewage water on chemical properties and heavy metal accumulation of sandy soils. Prolonged irrigation with sewage water decreased the pH, especially in the upper layer of soil. Total and soluble nitrogen, as well as available phosphorus increase with long use of sewage water; maximum accumulation was in the upper layer of soil. A similar distribution of lithium and heavy metals was also observed.

Mukherji & Sahai (1988) observed the effects of different concentrations of distillery waste on the seed germination, speed of germination index (SGI), seedling establishment, early seedling
growth, dry weight and seed output of *Cajanus cajan*. No germination was found to occur in 100% concentration of the effluent. The 5% concentration of the effluent provided optimum conditions for SGI, seed germination, seed output and dry weight, beyond which these parameters decreased. Seedling establishment was 100% up to 5% concentration after which it decreases. The shoot length was maximum in 2.5% concentration. Thus it is evident that distillery effluent is very toxic in higher concentrations to the growth of plants and in lower concentrations (2.5 and 5%) the effect is useful and therefore, the effluent after dilution to lower concentrations can be pat to use for irrigation purposes.

Sahai & Srivastava (1988) used various concentrations of a fertilizer factory to know their impact on seed germination, seedling growth and pigment content of vegetables like *Phaseolus vulgaris* and *Momordica charantia*. With increase in effluent concentration, there was a gradual decrease in percent germination, rate of germination and chlorophylls. High contents of nitrogen were found to be a major toxic factor which inhibits seed germination when grown in high effluent concentrations. No germination occurred in 75% and 100% concentrations. Results also show that effluent up to 2.5% concentration is beneficial and show promotion of various parameters studied. Bahadur & Sharma (1989) pin-pointed the effect of water from nullah receiving the mix effluent from 3 industrial units in Bareilly on biomass production and net primary productivity of wheat at the age of 60, 75, 90, 105, 120 and 135 days. Decrease in biomass and NPP was observed in the treated plants as compared to control at each
harvest. This effluent was found to contain suspended and dissolved solids, oil, grease, Pb, Cr, Na above their tolerance limits. These pollutants cause adverse effect on various metabolic activities.

Mukherjee and Sahai (1988) studied the effect of distillery waste was observed on the seed germination, speed of germination index (SGI), seedling establishment, early seedling growth dry weight and seed output of Cajanus cajan L. For this 1, 2.5, 5, 10, 15, 25, 50, 75 and 100 percent concentrations of the effluent were used. No germination took place in 100 percent concentration of the effluent. The 5 percent concentration of the effluent provided optimum conditions for seed germination, SGI, seed output and dry weight, beyond which these parameters decreased. Seedling establishment was 100 percent up to 5 percent concentration after which it decreased. The shoot length was maximum in 2.5 percent concentration.

Bhargava (1989) described the effect of heavy metal, Zn on seedling growth, nitrogen and phosphate distribution in three varieties of Vigna radiata, (PS7, PS16 and PB). These varieties were found to respond differentially to 10 and 50 mg/l zinc concentration. Both these concentrations have inhibitory effect on the transfer of N and P from cotyledon to various seedling parts. All growth parameters show reduced growth as compared to control. Frossard et al. (1989) studied the effects of several heavy metals on some physiological aspects of rye grass. Biochemical aspects like analysis of fructose, sugar and starch content etc. were measured as affected by heavy metals. Bahadur & Sharma (1990)
studied the effect of industrial effluent in relation to seed germination and seedling growth on a variety of wheat. Percentage germination of seeds decreased significantly and the decrease was maximum (46.75 %) on the first day. Significant decrease was observed for root and shoot length, the shoot length was much more affected than root length. The increased concentration of various metallic ions (Fe, Cu, Mg, Pb, Mn, Hg) in the effluent are responsible for delay in seed germination and inhibition of seedling growth of wheat. Certain other inhibitory products in the effluent are beyond the tolerance limits and cause depletion of oxygen and poor absorption of water.

Juwarkar et al. (1990) evaluated the effect of distillery wastewater irrigation on nodulation and nutritional quality of groundnut with respect to its toxicity to *Rhizobium* and fruit formation. Protein contents and *Rhizobium* population in groundnut were adversely affected due to this irrigation. It was probably due to high percentage of total nitrogen in the wastewater. The protein contents in fruits irrigated with wastewater were 28.96 % against 53.60 % with tap water irrigation. Mean of nodules per plant irrigated with wastewater was 12 against 159 per plant irrigated with tap water.

Rajendran (1990) surveyed the effect of distillery effluent on the seed germination, seedling growth, chlorophyll content and mitosis in *Helianthus annuus*.

Kannabiran & Progasam (1993) observed the effects of distillery effluent on seed germination, seedling growth and

Subramani et al. (1995) also studied effect of distillery effluent on growth and productivity of *Vigna radiata*.

Sen and Behera (1997) suggested that cement factor from Hira Cement Factory, Bargarh (Orissa) retards germination of paddy seeds. Chlorophyll (Chl.), carotenoid and sugar levels on leaf increase during first week of germination but decrease in the 2nd, 3rd and 4th week when treated with the effluent. They further said that industrial effluents are important sources of water and soil pollution. The toxic chemicals present in them also affect the growth of plants. They have some effects in agriculture as they contain some essential nutrients of plants. The aim of the present investigation is to study the effect of cement factory effluent on germination, pigment content and sugar level in paddy (*Oryza sativa* L.) plants.

Subramani et al. (1998) reported the impact of fertilizer factory effluent on morphometrical and biochemical changes of *Vigna unguiculata* has been assessed. The different concentrations (0, 5, 10, 25, 50, 75 and 100 %) of fertilizer effluent were prepared and used for germination studies. Various morphometrical parameters and biochemical changes were analyzed on the seventh day after germination. The morphometrical parameters like shoot
length, root length, number of lateral roots and root/shoot ratio showed a decreasing trend with the increase in effluent concentration. However all the growth parameters showed a marked increase at 10 % level when compared with control.

The reduction in chlorophyll-a, chlorophyll-b, carotenoid contents and metabolites like sugar, starch, protein and aminoacids were noticed at higher concentrations. The 10% effluent concentration showed a similar trend as in the case of morphometrical parameters. The present study suggests that 5% effluent concentration is beneficial for the overall growth of the crop plant. Baruah & Dass (1998) studied the effect of Paper Mill effluent on physico-chemical characteristics of soil. Similarly Prashonthi & Rao (1998) studied effect of industrial effluent and polluted water on germination of crops.


Sahu and Dwivedi (1999) studied the effect of Fly ash on seed germination of two crops. The plant species selected for experiments were Vigna mungo and Abelmoschus esculentus. The effect of fly ash at 25%, 50% and 75% concentration was studied on seed germination, plant growth and chlorophyll content of both the plants. The result recorded showed that seed germination was highest at 25% concentration of fly ash, while the plant growth of both the cultivars was best at 50% concentration. The chlorophyll content was maximum at 50 % concentrations on 30th day in Vigna mungo plants whereas it was maximum at 25 % with A. esculentus.
plants on 30th day. Fly ash, an amorphous ferro-alumino silicate, is an important solid waste around steel and thermal power plants. Fly ash consists of very minute glass like particle size from 0.01 to 100 mm. Fly ash is generated during combustion of coal in coal fired power plants. Fly ash contains higher concentration of essential plant nutrients, except N, then do common agricultural soils. It is very uncommon in use because of its high alkalinity and presence of high contents of trace elements which suppress plant growth and deteriorate soil properties.


Kumar (2001) studied the effect of sugar mill effluent. Thus, impact of periodic watering from germination to maturity with carbonaceous sugar mill effluent on chemical constituents of soil and Hordeum vulgare var IB65 was assessed. Watering with effluent caused alteration in chemical constituents of soil and such alteration resulted in reduction in phosphate, potassium, total nitrogen, carbohydrate, crude protein and increase in Sodium, Calcium, Sulphate, Chloride and Ash content of root, stem, leaf and seeds of Hordeum vulgare var IB65.

Kumarwat et al. (2001) studied the effect of the industry effluent on germination of growth of two rabi crops.

Pragasam & Kannabiram (2001) studied effect of distillery effluent on some parameters. Result showed in increase over
control in 10 and 25 percent concentrations. The higher concentrations (50, 75 and 100 percent) were found to reduce growth and yield. They further said that the distillery effluents can be used as liquid fertilizer after appropriate treatment and desired dilution. Pandurangamurthy & Leelavati (2002) studied effect of Ganeho & Apron on growth and chlorophyll content of sun flower.

Jain & Bhargava (2003) studied the effect of metal Iron on seed germination and seedling growth in *Vigna mungo*, Linn. They found that lower concentration promotes growth & higher concentration inhibits germination & seedling growth.


Sonali & Bhargava (2004) studied the effect of Neem oil on growth characteristics of *Cicer arietinum*. Singh et al. (2005) studied the effect of polluted river water on seed germination and seedling growth of *Cicer arietinum* cv. H208.

Bhargava and Sonali (2005) also worked on the effect of Paper Mill effluent on seed germination and seedling growth of *Vicia faba*. Observation shows that higher concentration inhibits the growth.
Sharma et al. (2005) worked on the effect of Pragati Paper Mill Industry Pvt. Ltd. Site 4, Sahibabad, U. P. on Chlorophyll content of some medicinal plants such as *Calotropis procera* R. Br. and *Solanum xanthocarpum* Schard & Wendl were studied. The Chlorophyll content showed a decreasing trend in the selected plants growing around the industry, under the impact of paper mill effluent as compared to plant irrigated with normal water. The effluent was found to be acidic in nature (pH 3.6) with higher B.O.D. & C.O.D. The growth of a plant depends upon the amount of Chlorophyll content, because Chlorophyll is the main pigment involved in the production of organic matter. The Chlorophyll content is an ecological index as well as growth parameter. The amount of Chlorophyll content present in a leaf is directly correlated with the growth of a plant. The correlation between growth transition of green plants, which grow out-doors and are continuously exposed to pollutants have helped to decipher many pollution zones. Plants sensitive to particular pollutant show visible symptoms like Chlorosis, necrosis and growth retardation. All these morphological manifestations result due to physiological disturbances, caused by pollutant. In this way physiological studies are of paramount importance in detecting effect of pollution within the plant. It has been suggested that by increasing photosynthetic efficiency production could be increased. Singh et al. (2005) studied the effect of polluted river water on seed germination & seedling growth of *Cicer arietinum* cv. H. 208.

Indira and Mohanty (2006) worked on the effect of Sugar Mill effluents on *Eleusine coracana* L. was studied. The effluent
significantly inhibited germination, root and shoot length. The biochemical injury does not appear spontaneously but with the increase in effluent treatment there is reduction in observed biochemical parameters (Chlorophyll, Protein, Amino acid, Nucleic acids and Carbohydrate), which was negatively correlated. The shoot of the seedlings were found to be resistant where as root of the seedlings were susceptible to sugar mill effluent treatment.

Kumar (2006) carried studies on the effect of steel factory effluent on seed germination and seedling growth of Phaseolus mungo cv. T-9, shows that increasing concentration of effluent induced a gradual decrease in germination percentage. The maximum seedling growth occurred in 25% concentration of effluent and minimum at 100%. Kumar (2006) suggested that population explosion has resulted in heavy industrialization. The industries are the cause of different type of pollution. One of the major problems is the discharge of the industries dumped into our atmosphere. The industrial effluents are generally considered harmful but sometimes used for irrigating various crops. Many workers have shown the problem of wastewater production from various chemical industries and its effects upon the plants.

Kumar et al. (2006) studied the effect of automobile exhaust of N, P and heavy metal content of road side soils and anther of rice plants grown on these soils. Thus a study was taken up to 100 meter distance away from road side in order to assess the effect of automobile exhausts on N, P and heavy metal status of road side soils and their impact on uptake of same in anther part of rice plants grown on these soils. Effect of automobile exhaust on road
side crop plant, particularly sugarcane have been studied by Bhargava et al. (2003) and Richa et al. (2003).


Soundarran et al. (2007) studied the impact of distillery spentwash on growth, yield and quality of Bhindi (Abelmoschus esculentus) on alfisol. Thus, a pot culture (experiment was conducted during the period of Jan-May 2003 in order to study the impact of the distillery spentwash on growth, yield and quality parameters of Bhindi Abelmoschus esculentus (L) Moench var. Arka Anamika and the results showed that 50 times diluted effluent followed by 25 times dilution + 50 % OR are significantly increased the yield and also the quality parameters like ascorbic acid, crude protein, crude fibre content. It increases the nutrient uptake and enhanced the fertility status of the soil. In this decade, a number of countries including India have gone through rapid industrial growth, leads to considerable pollution problems. Even the most sophisticated chemical analysis is just inadequate to identify the biologically active compounds present in waste. Agricultural usages of these effluents are the safest and cheapest disposal for a safer environment along with super quantity of agricultural production. Continuous using of straight fertilizers in modern agriculture has made the soil exhausted and leads to the depletion of secondary and trace elements. This depletion must be replaced by some sources among all the sources use of organics is the cheap and safe method.
Among the sugar factory wastes press mud is well recognized organic manure and is being utilized by sugarcane farmers, but in molasses after extraction alcohol a tremendous amount of distillery effluent can be released. Its disposal range is for every litre of alcohol produced 15 to 20 litre of distillery spentwash is discharged. The encouraging characteristics of spentwash is that its decomposition rate in soil is four times faster than farm yard manure and it has exorbitant load of secondary nutrients like Ca, Mg and S. So its ameliorative potential in the reclamation of sodic soil can be well exploited. Keeping the efficient management of distillery spentwash in the production of irrigating bhindi crop, a detailed experiment was conducted at ICFRI, Madurai in pot culture green house with alfisol (Typic haplustalf) of Maddukkur series. The test variety is a very popular variety viz. Arka Anamika. Reshu & Bhargava (2007) studied the effect of Cadmium on seed germination and seedling growth of Vigna radiata. Rout et al. (2007) studied effect of pharmaceutical effluent on morphological and biological parameter in Vigna radiata.

TOLERANCE OF CERTAIN POLLUTANTS IN PLANTS:

Antonovics et al. (1971) gave list of plants which can tolerate high concentrations of heavy metals. McNaughton et al. (1974) observed heavy metal tolerance in Typha latifolia. Clones’ of this plant and soil samples were obtained from a Zn smelter and from a central location in U.S.A. In this smelter location, soil Pb content was 16 times higher, Cd content 37 times higher and Zn 385 times higher. No evidence for the evolution of heavy metal tolerance
could be detected in 2x2 experiments in which genotypes from both locations were inhibited on the heavy metal soil but not to extent that would be expected from previous studies of heavy metal effects. This is the first case describe in which a species was able to colonise heavy soil in the absence of evolution of tolerant races.

Shiber & Washburn (1978) collected *Viva lactuca* at neame locations along the coast of Ras Beirut, Lebanon and analyzed for Pb, Hg, P, Ca, Mg, Fe, Cu and Zn. Low Pb concentration in all samples could possibly indicate that *Viva lactuca* has some means by which Pb uptake and toxicity can be controlled. Phosphate levels may be a contributing factor in this process. Concentrations of all other elements seemed relatively uniform with few exceptions. *Viva lactuca* is apparently subjected to similar environmental conditions and element exposure at each of the collecting sites and might be capable of maintaining biochemical stability under high levels of stress. Besides the use of tolerant species, several other pollution control measurements can be applied.

Von Assche & Jansen (1979) suggested that selectively working cation exchangers (lewatit O° 1029, O° 1030, O° 1034, Bayer AG, Kusen) are very effective for the immobilization of ions of heavy metals Zn++, Cu++, Pb++). Applied at the calculated doses in a soil and/or substrate contaminated with ions of heavy metals, these cation exchangers withdraw the contaminants from the existing equilibrium system, which results in a neutralization of the fraction of the undesired phytotoxic identities. This method not
only offers many possibilities in common peat and leaf mold soils, but gives a guarantee for plant production in contaminated autochthonous areas and heterochthonous substrates. Ornamental plan stand nursery trees developed well, especially in a terminated emission atmosphere, even in very strongly contaminated soils.

Walsh et al. (1979) treated seedling of red mangrove (Rhizophora mangle) twice with 25, 250 or 500 Cd/g soil; 62.5, 125 or 250 μg Pb/g soil; or 10; 100 or 500 μg Hg/g soil. There was no effect of any metal on final weight and Size of hypocotyls, stems, roots or leaves; the time at which the stem emerged from the plumule or the time at which the first pair of leaves unfurled from the stem. Lead was not trans located by the seedlings but Cd and Hg were. The authors suggested that tolerance of Rhizophora mangle seedlings to high concentrations of Cd, Pb and Hg could be due to formation of non-toxic sulfides in the root or on its surface, detoxification in tissues, an ion-exclusion mechanism in the roots or a combination of these factors.

Homer et al. (1981) identified and collected two races of Phalaris arundinacea, one tolerant and other intolerant to Pb. Addition of Pb to isolated leaf segments caused stimulation of light induced leaf fluorescence and inhibition of O2 evolution. Higher Pb concentrations were required to elicit these effects in the tolerant grass compared with the non-tolerant grass. Estimation of leaf chlorophyll showed a higher ratio of chlorophyll b to chlorophyll a in leaves from the tolerant grass than the non-tolerant one. The light induced O2 evolution rates, on a chlorophyll basis were higher in the leaves from tolerant grass. Leaf total chlorophyll
content was similar from both races. Effects of the inhibitors 3-(3,4- dichlorophenyl); 1, 1-dimethyl Urea and Antimycin a on leaf fluorescence suggested that rates of non-cyclic electron transport were greater in leaves from Pb tolerant plants. Photo system II activity apparently was greater in Pb tolerant plants. Bhargava (1995) reported some tolerant plants. Foy (1995) also studied the effect of Mn on heavy metal tolerances in plants. Srivastava & Purnima (1999) also reported certain heavy metal tolerant species. Richa (2005) reported some heavy metal tolerant species. Likewise, Shobhna (2006) also gave list of tolerant species.

EFFECTS OF POLLUTED STREAM ON PLANT DISTRIBUTION:

Antonovics et al. (1971) reported that certain plant species are often inordinately abundant in soils that are high in certain elements while some plants are largely restricted to soils that are abundant in a given heavy metal and have been used as indicators of its ores. They reported the distribution of certain tolerant species of Europe which are widely distributed in vicinity of polluted water. Bradshaw (1976) viewed the mechanism of action of tolerance to pollution in plants. He suggested that almost in every ecosystem certain number of species survive whereas rest disappear. He has also listed out few important species which do occur in polluted environment. Treshow (1980) reviewed pollution effects on plant distribution. He referred that success of a population of plants or animals depend internally on its genetic diversity. The presence of particular gene-combinations and variations among individuals in the population give the species
other taxon, the capacity to adopt in the environment. He also presented a list of some species found distributed in nearby polluted stream.

Mhatre et al. (1980) reported effect of industrial pollution on the Kalu river ecosystem. They found that a plant species *Pycreus macrostachyos* along the bank of the polluted estuary was probably the result of contamination of the estuary. The species was also found to be an accumulator of heavy metals such as Hg, Pb, Cd and Cu. Singh & Bhargava (1984) studied on the plant distribution as affected by the confluence of a polluted stream with a clean stream at Meerut. Occurrence and distribution of aquatic plants growing on the river bank were studied at one side before confluence close to polluted discharge through sugar mills and distillery and at two site after the clean and polluted streams confluence on wards at some distance. This work reports on the distribution of aquatic and terrestrial plants in this set up. Total seven species of angiosperms reported in and around the vicinity. Treshow (1980) worked on effects of pollution on plant distribution.

Sahai et al. (1985) worked out ecological survey of the algal flora of polluted habitats of Gorakhpur. A survey of the algal flora of habitats polluted with effluents of fertilizer factory, sugar factory, distillery, and township sewage has been made. The distributional pattern has been correlated with the physicochemical characteristics of the effluents, 35 genera of algae were collected. In all the polluted habitats cyanophycean members dominated. While only *Oscillatoria* was dominant in fertilizer factory effluent and township sewage, *Oscillatoria, Microsystis,*
Chlorella, Closterium and diatoms were dominant in sugar factory and distillery effluents. Total nitrogen, phosphate and chloride contents played a vital role in their distribution patterns.

Srivastava (1988) studied on the effects of effluent of Surya sugar factory of Gorakhpur on plant distribution. He found that pollution due to this factory causes deterioration of quality and flora of the adjacent local stream. This factory discharges about 3,00,000 litres of effluent per day in Baisy and Faren streams. The physico-chemical and biological characteristics of this habitat were studied. It revealed that water samples contain high concentration of N (3.80 ppm), bicarbonate (1120 ppm), free CO2 (31500 ppm) and sugar content (0.25 to 0.38%) and pH 6.4 to 8.2. This effluent has a noted effect on the distribution pattern of plants. Polygonum sp., Ranunculus sceleratus, Setaria glauca occurred close of water which is clean. The density of Veronica cinerea and Rumex dentatus was lower on the polluted side. Even the ubiquitous species Cynodon dactylon was considerable depressed. However, some plants especially Alternanthera sessilis and Amaranthus spionsus occurred more on polluted side and hence can serve as indicator plants for such habitats. Shobha (2006) gave large amount of details of plant distribution along polluted river water studies in stomatal resistance, temperature and senescences.

Salisbury (1927) studied the development of stomata in family Papilionaceae & gave details of stomatal resistance. Leopold (1961) worked out the effect of ageing in plant and also gave senescence effect during plant development.


Chakraborty (1977) studied epidermal structure and stomatal characteristics of some Vigna sp. Singh et al (1980) studies the effect of soil moisture status on leaf water potential status, stomatal resistance, leaf temperature and evapo-transpiration in pearl millet.

Yadav & Singh (1981) also studied the effect of irrigation and antitranspirants on plant water relation, characteristics, leaf temperature and the yield of Barley. Mei and Thimann (1984) noted the relation between nitrogen deficiency and leaf senescence.

plays an important role in improving nutritional role of Mulbery leaves.

Thakur & Patil (2007) studied the foliar epidermal studies in some hitherto unstudied euphorbiaceae.

Susheelamma et al (2007) concluded that the chlorophyll content has shown interrelationship with important qualitative traits and highly significant positive correlation with all the traits of foliage.

POLLUTION CONTROL MEASURES:

The reuse of wastewater for agricultural use is an old and common practice. Law (1968) cited 99 references on the use of sewage effluent as an agriculture water resource in various parts of the world. The quality of the reused water is an important factor for the health of human beings; therefore, he recommended some measures for the treatment of industrial effluent and sewage sludge before use in agriculture. Conventional methods of treatments of industrial effluents and sewage sludge include primary and secondary treatment, and filtration and disinfection. Such treated effluent should contain not more than 100 coliforms/100 ml in 80% of the samples. This can be achieved by the application of 20 mg/litre of chlorine of 2 hours for effluent from a trickling filter (W.H.O. 1973).

Frazier & Westhoff (1977) indicated that when untreated domestic sewage is used to fertilize plant crops, there is likelihood that raw plant food may be contaminated by human pathogens. The
domestic sewage contains various species of pathogenic microbes such as those causing typhoid fever. They also stressed that vegetables taken directly from the field were slightly contaminated with colic bacteria as compared to those which were washed with canal water. Before treatment, domestic sewage contains, the complete range of pathogenic microbes found in community. Various species of pathogenic microbes occur in sewage and therefore, he suggested proper washing and other measure for use of vegetable. Gadre & Godbole (1986) have suggested some measures for treatment of industrial waste. In an attempt to find out a suitable method for the treatment of the wastewater, studies were taken on two bench scale-up flow anaerobic filters for anaerobic digestion. Treatment of industrial waste using anaerobic filter would bring about quick degradation of organic content of the waste, thus significantly reducing the pollution load and would simultaneously produce biogas which can partly replace the costly fuel used in industries.

The possible use of water hyacinth (Eichhornia crassipes) in wastewater treatment was studied by Trivedy & Gudekar (1985). It removes BOD, COD, N, P, organic carbon, suspended solids, Hg, faecal coli forms and other bacteria from wastewater. The BOD was reduced by 86.76 %, P by 20 %, COD by 94.15 % and TSS (total suspended solids) by 98.07 %. Petiole and roots of this hydrophyte absorb a fair amount of nitrogen and phosphorus from wastewater. In roots, total N was 1.789 mg/l and total P by 0.309 mg/l. in petioles, total N was 2.171 and P was 0.423 mg/l. Tripathi
& Shukla (1991) reported that *Lemma, Salvia* and *Spirodela* have pollutant removing efficiency.

In many places, large scale action has been launched to prevent further destruction of the natural environment. On 23\textsuperscript{rd} March, 1974 the water prevention and control of pollution act, 1974 was enacted in India. Further on 12\textsuperscript{th} December 1978, the water amendment act 1978 was enacted in India. This is an act to amend the water prevention and control of pollution act. On 29\textsuperscript{th} March, 1981 the air (prevention and control of pollution) act 1981 was formulated. On 21\textsuperscript{st} June, 1984 Govt. of India, Ministry of industry imposed certain conditions for collection of letter of intent to set up an industry. These conditions are based on pollution control measures. The limits prescribed by Ministry of health, Govt. of India for certain heavy metals in human drinking water are given in table - 1.
TABLE 1: Showing Permissive and Excessive Concentrations of Heavy Metals (in ppm)

<table>
<thead>
<tr>
<th>Metals</th>
<th>Permissive</th>
<th>Excessive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>0.05</td>
<td>0.20</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.05-1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.30</td>
<td>1.00</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.10</td>
<td>0.50</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>0.10</td>
<td>0.05</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>5.00</td>
<td>15.00</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.1</td>
<td>50.00</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>5.00</td>
<td>30.00</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

The drinking water supplies in which any of mentioned heavy metal (Table-1) is present in excess of the allowed concentration, must be rejected, as unfit for human consumption (Pande, 1976).

The pollution problem can be solved through a multiple attack. Thus, major suggestions of various boards are incorporated in the following :-

(i) Communication of research findings to industries and constitution of pollution oriented section in industrial R & D. At present there is no system of involuntary
communication between industries and research institutions.

(ii) Research institutes must help in the design of treatment units for industrial effluents.

(iii) Consideration must be given to the waste disposal scheme at site selection stage itself.

(iv) There should be maximum recovery of raw materials/products from the effluents to limit pollution as well as to provide economy.

(v) The importance of good house-keeping and preventive maintenance must not be forgotten. These measures can reduce the waste by as much as 15-20%.